P 15: HEPP V

Time: Wednesday 14:00–16:10 Location: ELP 6: HS 3

Invited Talk P 15.1 Wed 14:00 ELP 6: HS 3

Particle fueling, profiles and transport in neutral beam heated plasmas at Wendelstein 7-X — •Sebastian Bannmann, Oliver Ford, Peter Poloskei, Jakob Svensson, Samuel Lazerson, Hakan Smith, and Robert Wolf — Max-Planck-Institut für Plasmaphysik, Greifswald, DE

A spontaneous reduction in anomalous particle transport in the plasma core is seen experimentally in reproducible, purely neutral beam (NBI) heated plasma phases at Wendelstein 7-X (W7-X). A significant acceleration of the density peaking occurs after a certain onset time and is examined with a detailed particle transport analysis in several discharges. By invoking the particle continuity equation, the total experimental radial electron flux is deduced from the time evolution of the electron density profile and the radially resolved particle sources. To calculate the neutral beam particle deposition a full collisional-radiative (CR) neutral beam injection model based on Gaussian pencil (Gausscil) beams and a diffusive CR neutral halo model is implemented and verified. All important parameters defining the neutral beams are inferred from Balmer-alpha (Halpha) emission data and compared to available reference values. By employing Bayesian inference techniques provided by the Minerva framework, the full electron density profile from the plasma core to the edge is inferred solely from neutral hydrogen beam and halo Halpha emission data. Exploiting the evolving plasma conditions, anomalous diffusion and convection coefficients are successfully computed from the flux variation with density and density gradients.

P 15.2 Wed 14:30 ELP 6: HS 3

Effect of the newly installed cryo-vacuum pump on neutral gas pressures and particle exhaust — •Victoria Haak, Chandra Prakash Dhard, Thierry Kremeyer, Dirk Naujoks, Georg Schlisio, and W7-X Team — Max-Planck-Institut für Plasmaphysik, Greifswald, Germany

Gas exhaust is a key requirement for density control in a fusion device and, apart from the pumping speed and the subdivertor geometry, strongly dependent on the neutral gas pressure in the subdivertor and in front of the pumps. In each of the ten island divertor modules in Wendelstein 7-X, a cryo-vacuum pump (CVP) has been installed for the last campaign (OP2.1) to improve the particle exhaust capabilities. During dedicated gas injection tests, the pumping speed of the CVPs has been determined for hydrogen ($70\,\mathrm{m^3/s}$), nitrogen ($21\,\mathrm{m^3/s}$), neon ($22\,\mathrm{m^3/s}$) and argon ($9\,\mathrm{m^3/s}$). No significant differences in the neutral gas pressures in the subdivertor have been observed in discharges with and without CVPs in operation. Overall, neutral gas pressures on the order of few times 10^{-4} mbar were measured in the subdivertor region, which still corresponds to the molecular flow regime in which the effect of the cryo-vacuum pump on particle exhaust is limited.

P 15.3 Wed 14:55 ELP 6: HS 3

Heat Load Optimization for the Island Divertor of the Wendelstein 7-X Stellarator — •Amit Kharwandikar[1], Dirk Naujoks[1], Felix Reimold[1], Ralf Schneider[2], and The W7X-Team[1] — [1]Max Planck Institute for Plasma Physics, Greifswald — [2]Universität Greifswald, Greifswald

The Wendelstein 7-X (W7-X) stellarator implements the island divertor concept and has demonstrated the viability of using magnetic islands as a exhaust solution for low-shear stellarators. During the experiments, the divertor design revealed challenges in two aspects in particular: unexpected hotspots that limited operation and a poor neutral particle exhaust, motivating an investigation of new geometries to advance the W7-X island divertor. Early stages of such an exploratory challenge calls for fast and simple tools to scan the large 3D design space. In the same spirit, this contribution proposes a framework to analyse the heat flux compatibility of new divertor geometries.

The problem is approached in 2 steps - first, obtaining a simple picture of heat transport in an island scrape-off layer (SOL) to build fast predictive models of target heat flux distribution, followed by shape exploration of target geometries. In terms of tools, we utilize the Monte-Carlo code for 3D SOLs, EMC3-Lite, and compliment it with a newly developed empirical approach - Simple model for loads in island divertor (SMoLID) - based on estimating the SOL width and perpendicular transport length scales for a given magnetic topology and plasma conditions. Eventually, these tools are applied to investigate the heat load compatibility of certain "closed" divertor geometries.

P 15.4 Wed 15:20 ELP 6: HS 3

Investigations of impurity concentration in seeded divertor plasmas of W7-X via line ratio spectroscopy — •Frederik Henke, Maciej Krychowiak, Felix Reimold, Ralf König, Dorothea Gradic, Erik Flom, and Victoria Winters — Max Planck Institute for Plasma Physics, Wendelsteinstr. 1, 17491 Greifswald, Germany

In future fusion power plants, managing power exhaust in the divertor poses a significant challenge, requiring seeding of extrinsic impurities. Retaining these impurities at the plasma edge is crucial to avoid fuel dilution and radiative energy losses in the core, limiting the reactor's operational space.

Ongoing research explores power exhaust scaling with spectroscopically measured impurity concentration and machine parameters in tokamak plasmas. This study focuses on measuring multiple spectral lines of the same impurity ion using passive divertor spectroscopy, employing their ratios to reconstruct local plasma parameters.

W7-X's recent operational campaign featured experiments with various seeded impurity species, revealing challenges in the analysis. Notable variations in measured line ratios among different magnetic configurations indicate distinct local plasma parameters. Due to different plasma conditions in the divertor, line-ratio analysis methods require re-validation. This study presents initial results of impurity concentrations, discussing factors influencing the diverse behavior of line ratio measurements.

P 15.5 Wed 15:45 ELP 6: HS 3

Investigation of radiation distribution and scaling for power exhaust in W7-X — •Gabriele Partesotti[1], Felix Reimold[1], Glen Wurden[2], Daihong Zhang[1], and Byron Peterson[3] — [1]Max-Planck Institute for Plasma Physics, Greifswald, Germany — [2]Los Alamos National Lab, Los Alamos (NM), USA — [3]National Institute for Fusion Science, Toki, Japan

Radiation emission is one of the main heat loss channels for magnetically confined fusion plasmas. In terms of performance, its effect can be either beneficial - e.g. mitigation of power load on the plasma-facing components - or detrimental - e.g. core cooling, radiation collapse. Still, the toroidal distribution of radiated power in a stellarator machine and its behavior in the island divertor are not fully understood yet. In light of this, the present work aims to study the three-dimensional characteristics of radiation in the stellarator geometry of Wendelstein 7-X (W7-X), and its sensitivity to magnetic configuration and plasma parameters. The analysis begins with an introduction of the diagnostic systems, including both resistive and infrared imaging bolometers. It follows a description of the principal features of the W7-X edge radiation resulting from EMC3-EIRENE simulations. Based on these findings, a new concept of Compact Bolometer Camera (CBC) is designed and tested to improve diagnostic coverage and assess poloidal and toroidal radiation asymmetries. Finally, the toroidal variation of the radiated power distribution is investigated by comparing local measurements with projected tomographic reconstructions.